

# The Walking School Bus and Children's Physical Activity: A Pilot Cluster Randomized Controlled Trial

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## KEY WORDS

walking school bus, safe routes to school, school, active commuting to school, physical activity, children, obesity

## ABBREVIATIONS

MVPA—moderate-to-vigorous physical activity  
RCT—randomized controlled trial

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**WHAT'S KNOWN ON THIS SUBJECT:** Walking school bus programs have been reported to increase children's active commuting to school and physical activity, but most studies have used nonrandomized designs.



**WHAT THIS STUDY ADDS:** This article reports preliminary proof of concept that, in a rigorous cluster randomized controlled trial, a pilot walking school bus program improved children's active commuting to school and moderate-to-vigorous physical activity.

## abstract



**OBJECTIVE:** To evaluate the impact of a "walking school bus" program on children's rates of active commuting to school and physical activity.

**METHODS:** We conducted a pilot cluster randomized controlled trial among 4th-graders from 8 schools in Houston, Texas ( $N = 149$ ). Random allocation to treatment or control conditions was at the school level. Study staff walked with children to and from school up to 5 days/week. Outcomes were measured the week before (time 1) and during weeks 4 and 5 of the intervention (time 2). The main outcome was the weekly rate of active commuting, and a secondary outcome was moderate-to-vigorous physical activity. Covariates included sociodemographics, distance from home to school, neighborhood safety, child BMI z score, parent self-efficacy/outcome expectations, and child self-efficacy for active commuting. A mixed-model repeated measures regression accounted for clustering by school, and stepwise procedures with backward elimination of nonsignificant covariates were used to identify significant predictors.

**RESULTS:** Intervention children increased active commuting (mean  $\pm$  SD) from  $23.8\% \pm 9.2\%$  (time 1) to  $54\% \pm 9.2\%$  (time 2), whereas control subjects decreased from  $40.2\% \pm 8.9\%$  (time 1) to  $32.6\% \pm 8.9\%$  (time 2) ( $P < .0001$ ). Intervention children increased their minutes of daily moderate-to-vigorous physical activity from  $46.6 \pm 4.5$  (time 1) to  $48.8 \pm 4.5$  (time 2), whereas control children decreased from  $46.1 \pm 4.3$  (time 1) to  $41.3 \pm 4.3$  (time 2) ( $P = .029$ ).

**CONCLUSIONS:** The program improved children's active commuting to school and daily moderate-to-vigorous physical activity. *Pediatrics* 2011;128:e537–e544

Active commuting to school (ie, walking or cycling to and from school [henceforth termed active commuting]) has been positively associated with moderate-to-vigorous physical activity (MVPA) and inversely associated with BMI z scores.<sup>1</sup> Other epidemiologic studies have reported similar relationships.<sup>2,3</sup> Because most children in the United States attend schools that necessitate a commute, active commuting could help to broadly improve youth physical activity and prevent chronic disease.<sup>4–9</sup> Forty-two percent of children actively commuted to school in 1969–1970 versus only 13% in 2009.<sup>10,11</sup> Increasing the proportion of children who actively commute has been recommended to improve youth physical activity.<sup>12,13</sup>

The walking school bus—that is, a group of children led to and from school chaperoned by adults—addresses parental concerns for safety and encourages active commuting.<sup>14</sup> Walking school buses have shown promise toward increasing children's active commuting and physical activity,<sup>15–20</sup> but most studies were not randomized controlled trials (RCTs), lacked an objective measure of physical activity, or have not focused on low-income or ethnic minority children, who are most affected by childhood obesity.<sup>21</sup>

Applying a theoretical framework (eg, social cognitive theory)<sup>22,23</sup> that predicts obesity prevention behaviors could inform the design and evaluation of a behavioral intervention.<sup>24</sup> In cross-sectional analyses, parent self-efficacy (one's personal sense of control for a behavior) and outcome expectations (the expected outcomes [ie, costs/benefits] of performing the health behavior) for allowing their child to actively commute were positively associated with children's active commuting.<sup>25</sup> To the best of our knowledge, no study has applied a

theoretical framework to understand children's active commuting within an intervention study.

Our objective was to conduct a pilot cluster RCT of a walking school bus to determine its impact on children's active commuting and objectively measure physical activity. A cluster design was chosen because walking school bus programs are implemented at the school-level to easily facilitate formation of walking routes while restricting contamination between intervention and control children. The study had 2 hypotheses: the walking school bus program would increase children's (1) active commuting; and (2) daily MVPA. Secondary hypotheses included: (1) the walking school bus program would increase daily light physical activity; and (2) parent and child self-efficacy and parent outcome expectations for active commuting would be important determinants of changes in active commuting. All hypotheses pertained to individual-level outcomes.

## METHODS

### Participants

Low-income public elementary schools in the Houston Independent School District in Texas were recruited by study staff in the spring of 2009 on the basis of the following criteria: >75% of children qualified for the free/reduced lunch program (a proxy for school socioeconomic status), interest in accommodating the study in response to a district-wide solicitation, and informal observations on their walking environment (eg, presence of sidewalks, street connectivity, adjacent major arterial roads/highways). Inclusion criteria for child participants included enrollment in the 4th grade, living within 1 mile of school, and having no health limitations restricting walking to school. Exceptions to the 1-mile walk radius were made if parents agreed to transport their child to a walking

school bus stop within the 1-mile zone ( $n = 7$ ). At all study schools, children were enrolled in the study before random assignment of the study condition and agreed to participate in the program if their school was assigned the intervention. This study was approved by the institutional review board of Baylor College of Medicine and the Research Department of the Houston Independent School District.

### Intervention

The walking school bus program was based on national guidelines.<sup>14</sup> Each intervention school had 1 to 3 walking routes based on children's home addresses. Trained study staff walked the children to and from school up to 5 days/week, although children and parents decided on which days to participate. The control schools received the usual information provided by the school district on school transportation. The intervention and control conditions were administered from weeks 1 to 5 beginning in March 2009.

### Design

This pilot cluster RCT matched schools according to race/ethnicity and socioeconomic status and randomly assigned within pairs to the intervention ( $n = 4$ ) or control ( $n = 4$ ) conditions by drawing the study condition from a container. Time 1 measurements occurred before random assignment and initiation of the walking school bus program in March 2009. Time 2 measurements occurred during weeks 4 and 5 of the program. Walking school bus routes averaged 0.8 mile and had no more than 8 to 12 children per 2 staff members. Given the nature of the intervention, blinding of the participants, schools, and evaluation staff was not possible after random assignment and initiation of the program (ie, for time 2 measurements).

## Outcome Variables

All variables were measured at the schools and pertain to individuals. The primary outcome was the percentage of trips made by active commuting over 1 school week (percent active commuting), which was assessed every school day for 1 week during times 1 and 2 using a questionnaire with high test-retest reliability ( $\kappa = 0.97$ ;  $P < .001$ ) and convergent validity with parental report ( $\kappa = 0.87$ ;  $P < .001$ ).<sup>26</sup> The questionnaire asked in English (or Spanish) “How did you get to school today?” Children chose the 1 best answer in English (or Spanish): school bus, carpool, car, metro bus, walked with an adult, walked without an adult, or biked. Active commuting was operationalized as walking or biking to school, and the percentage of trips to school over 1 week was calculated for analyses.

The secondary outcome was MVPA (minutes per day) measured by using accelerometry, which provides a valid, objective measure of physical activity.<sup>27,28</sup> The participants wore the GT1M accelerometer (ActiGraph LLC, Ft Walton Beach, FL) over their hip for up to 7 days each at times 1 and 2. The GT1M’s unidirectional accelerometer measured acceleration in the vertical plane and intensity every minute during the wear periods. To facilitate comparisons to children’s physical activity in the National Health and Nutrition Examination Survey,<sup>1,29,30</sup> data were excluded if they did not meet quality standards.<sup>30</sup> A valid day was defined as  $\geq 10$  hours (600 minutes) of accelerometer wear; participants who had at least 1 valid day were included in analyses. Although at least 4 valid days have been recommended to estimate children’s habitual physical activity,<sup>28</sup> this standard would have decreased this pilot study’s sample by almost 33% and did not improve the intraclass correlation coefficient, which averaged 0.416 to

0.422 for 1 to  $\geq 4$  valid days. Of 149 participants, valid accelerometer data were obtained for at least 1 (91.2%), 2 (87.9%), 3 (79.9%), or  $\geq 4$  (75.0%) days at time 1. At time 2, the percentages were slightly less for 1 (89.9%), 2 (85.2%), 3 (80.5%), or  $\geq 4$  (70.5%) valid days of accelerometer data.

Age-specific thresholds for MVPA were set at 4 metabolic equivalents using the prediction equation developed in children by Freedson et al.<sup>31</sup> Total minutes above the threshold were divided by the number of valid days to obtain minutes per day of MVPA. Because walking to school may be classified as light-to-moderate intensity physical activity,<sup>32</sup> light physical activity ( $\geq 1.5$  and  $< 4$  metabolic equivalents) was also included. The selected prediction equation has shown higher accuracy for the included intensity thresholds compared with other prediction equations.<sup>33</sup>

## Covariates

Research staff followed a standardized protocol and measured participants’ standing height using the Seca 214 portable stadiometer (Seca, Hamburg, Germany) and body weight using a Tanita BWB-800S digital scale (Tanita Corporation of America, Inc, Arlington Heights, IL). The mean of 2 measures served as the recorded value. A third measurement was obtained when the difference between the initial 2 values exceeded 0.2 cm or 0.2 kg, and the closest 2 values were averaged. BMI was calculated by dividing weight in kilograms by height in meters squared, and the 2000 Centers for Disease Control and Prevention growth charts were used to calculate BMI z-scores.<sup>34</sup> BMI z-scores were not expected to change over the 4- to 5-week intervention period and were considered a covariate.

Participants’ parents completed a sociodemographic survey. Home addresses were used to calculate the

distance from home to school on [www.maps.google.com](http://www.maps.google.com) using the “Get Directions” function for pedestrians. Because acculturation was associated with Latino children’s active commuting to school in cross-sectional studies,<sup>25,35</sup> several proxy measures of acculturation were obtained, including parents’ and children’s country of origin and parents’ years living in the United States. The parent and child acculturation scores were summed to obtain a global measure.

Because safety was a primary concern for parents, perceived neighborhood safety was measured using a subscale from the Neighborhood Environment for Children Rating Scales, which rated the family’s neighborhood with regard to safety, violence, drug traffic, and child victimization.<sup>36</sup>

Applying the theoretical framework of social cognitive theory at time 1, children’s self-efficacy for active commuting was assessed using a 17-item questionnaire (Cronbach’s  $\alpha = 0.75$ ), parents’ self-efficacy for allowing their children to actively commute was assessed using a 15-item questionnaire (Cronbach’s  $\alpha = 0.88$ ), and parents’ outcome expectations was assessed using a 14-item questionnaire (Cronbach’s  $\alpha = 0.78$ ).<sup>25</sup>

## Sample Size

Given an effective sample size of 127 subjects, 2 groups, 2 time points, a correlation of 0.5 over time, and a repeated measures design, there was 80% power to detect a small ( $d = 0.25$ ) standardized effect (G\*Power Version 3).<sup>37</sup> Given an SD of 44% for the change in percent active commuting, this effect size translated to a detectable  $\geq 11\%$  difference in the change in percent active commuting between the 2 groups. A variance inflation factor was used to account for the clustering of children within the 8 schools: assuming an intraclass cor-

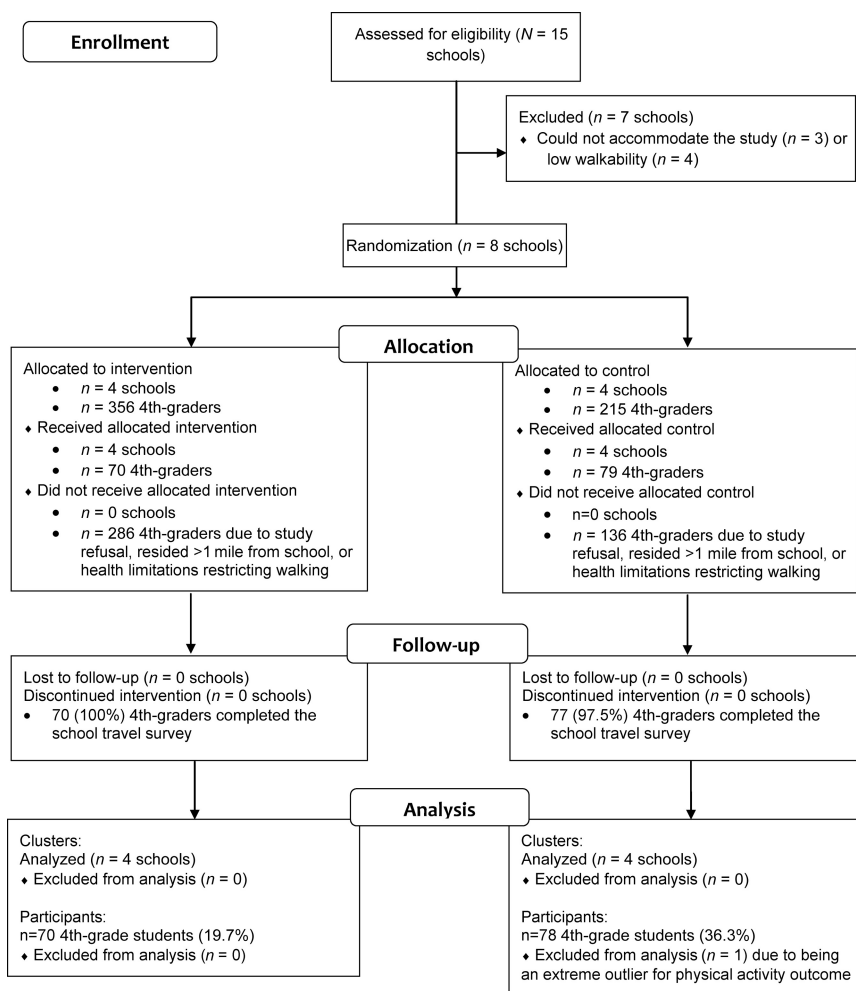
relation of 0.01 and a mean of 18 children per school, the actual sample size needed to account for clustering was 144. Accounting for minimal attrition (<5%), 151 children needed to be recruited.

## Statistical Analyses

Little's  $\chi^2$  test for data missing completely at random examined the models with the primary (active commuting) and secondary (MVPA) outcomes.<sup>38</sup> A Monte Carlo Markov chain algorithm was used to impute missing data.<sup>39</sup> Extreme outliers of percent active commuting and daily minutes of MVPA, defined as values greater than the upper quartile plus 3 (interquartile range),<sup>40</sup> were excluded from analyses. This criterion resulted in 1 participant's MVPA data (197 minutes/day) being excluded from analyses. Pearson correlations were used to examine associations between the potential mediators (child self-efficacy and parent self-efficacy and outcome expectations) and percent active commuting. A mixed repeated measures regression model that accounted for clustering by school determined the overall effect of the program on percent active commuting (hypothesis 1), minutes per day of MVPA (hypothesis 2), and minutes per day of light physical activity. Covariates included age, gender, race/ethnicity, parent education, family income, neighborhood safety, acculturation, and distance from home. Mediating variables (child self-efficacy and parent self-efficacy and outcome expectations) were included in the model for percent active commuting only. Stepwise procedures with backward elimination of nonsignificant ( $P > .1$ ) covariates identified significant predictors. All analyses were intention-to-treat, except where noted.

## RESULTS

Eight schools were selected from 15 that expressed interest in the study



**FIGURE 1**  
CONSORT (Consolidated Standards of Reporting Trials) 2010 flow diagram.

(Fig 1, adapted from the CONSORT [Consolidated Standards of Reporting Trials] study<sup>41–43</sup>). Seven schools were excluded based on their walking environments ( $n = 4$ ) or ability to accommodate the study ( $n = 3$ ). Four of the 8 study schools enrolled >75% Latino children, 2 schools enrolled 92% black children, and the remaining 2 schools were more evenly split between these groups. Of the total 571 children in 4th grade, 149 (26.1%) enrolled in the study, with 70 of 356 total (19.7%) at the intervention and 79 of 215 total (36.7%) at the control schools. No demographic data were collected on children whose parents did not provide informed consent, whether ineligible due to health limitations, distance

from home to school, or refusal to take part in the study; thus, an estimate of the percentage of children who participated and who lived within the 1-mile walk radius cannot be calculated, although it was >26.1%. No participants were lost to follow-up.

Some demographic differences existed between the intervention and control children at time 1 (Table 1): more intervention parents were born outside the United States ( $P = .027$ ) or resided in the United States for fewer years ( $P = .006$ ), and more intervention children lived farther from school ( $P < .001$ ). For percent active commuting at time 1, the control group ( $43.8\% \pm 43.9\%$ ) was higher than the intervention

**TABLE 1** Participant Characteristics Stratified According to Study Group

Characteristic	Control ( <i>n</i> = 79)	Intervention ( <i>n</i> = 70)	Total ( <i>N</i> = 149)
Gender, male, <i>n</i> (%)	37 (46.8)	33 (47.1)	70 (47.0)
Race/ethnicity, <i>n</i> (%)			
Non-Hispanic white	0 (0.0)	2 (2.9)	2 (1.3)
Non-Hispanic black	31 (39.2)	16 (22.9)	47 (31.6)
Hispanic	44 (55.7)	47 (67.1)	91 (61.1)
Other	3 (3.8)	3 (4.3)	6 (4.0)
Missing	1 (1.3)	2 (2.9)	3 (2.0)
Highest household education, <i>n</i> (%)			
High school graduate or less	53 (67.1)	35 (50.0)	88 (59.1)
Some college/technical/vocational school	10 (12.7)	16 (22.9)	26 (17.4)
College graduate	4 (5.1)	8 (11.4)	12 (8.1)
Missing	12 (15.2)	11 (15.7)	23 (15.4)
Annual household income, <i>n</i> (%) <sup>a</sup>			
≤\$30 000	53 (67.1)	23 (32.9)	76 (51.0)
>\$30 000	11 (13.9)	22 (31.4)	33 (22.1)
Missing	15 (19.0)	25 (35.7)	40 (26.8)
Child's country of birth, <i>n</i> (%)			
Outside the United States	14 (17.7)	16 (22.9)	30 (20.1)
United States	65 (82.3)	52 (74.3)	117 (78.5)
Missing	0 (0.0)	2 (2.9)	2 (1.3)
Child's length of residence in the United States, <i>n</i> (%)			
≤5 y	5 (6.3)	8 (11.4)	13 (8.7)
>5 y	74 (93.7)	60 (85.7)	134 (89.9)
Missing	0 (0.0)	2 (2.9)	2 (1.3)
Parent's country of birth, <i>n</i> (%) <sup>a</sup>			
Outside the United States	40 (50.6)	46 (65.7)	86 (57.7)
United States	39 (49.4)	21 (30.0)	60 (40.3)
Missing	0 (0.0)	3 (4.3)	3 (2.0)
Parent's length of residence in United States, <i>n</i> (%) <sup>a</sup>			
≤15 y	21 (26.6)	33 (47.1)	54 (36.2)
>15 y	58 (73.4)	35 (50.0)	93 (62.4)
Missing	0 (0.0)	2 (2.9)	2 (1.3)
Child's age, mean ± SD, y	9.8 ± 0.7	9.7 ± 0.6	9.7 ± 0.7
Distance to school, mean ± SD, km <sup>b</sup>	0.5 ± 0.4	0.9 ± 0.7	0.7 ± 0.6
BMI z score, mean ± SD	1.1 ± 1.2	1.1 ± 1.0	1.1 ± 1.1
Active commuting, mean ± SD, %/wk <sup>b</sup>	43.8 ± 43.9	22.9 ± 40.2	33.7 ± 43.3
Child self-efficacy, mean ± SD	36.9 ± 5.5	36.9 ± 6.4	36.9 ± 5.9
Parent self-efficacy, mean ± SD	33.9 ± 6.6	33.6 ± 6.9	33.8 ± 6.7
Parent outcome expectations, mean ± SD	20.9 ± 4.5	19.9 ± 4.0	20.4 ± 4.3
Moderate-to-vigorous physical activity mean ± SD, min/d	45.1 ± 27.8	46.6 ± 18.9	45.8 ± 23.9
Neighborhood safety, mean ± SD	10.2 ± 6.4	8.8 ± 6.9	9.6 ± 8.7

Missing data not included in tests of association.

<sup>a</sup> Significant  $\chi^2$  tests of association for income ( $\chi^2 = 12.58$ , degrees of freedom = 1;  $P < .001$ ), parent's country of birth ( $\chi^2 = 4.87$ , degrees of freedom = 1;  $P = .027$ ), and parent's length of residence in the United States ( $\chi^2 = 7.57$ , degrees of freedom = 1;  $P = .006$ ).

<sup>b</sup> Significant difference in group means for distance ( $t = -3.90$ , degrees of freedom = 146;  $P < .001$ ) and % active commuting per week ( $t = 2.95$ , degrees of freedom = 139;  $P = .004$ ).

group (22.9% ± 40.2%) ( $P = .004$ ). Although 67.1% of the control group were from households with an income ≤\$30 000 compared with 32.9% of the intervention group ( $P < .001$ ), there was more missing income data in the intervention group (35.7%) than the control group (19.0%), which could have contributed to the differences observed. When examining all baseline

characteristics and outcome measures, data were not missing completely at random ( $P = .036$ ). After removing family income and parent education, the data were considered missing completely at random ( $P = .189$ ). Because of the large number of missing data for income and parent education and because all schools predominantly served low-income families

(≥84% qualified for the free/reduced lunch program), these variables were excluded from the analyses. Multiple imputation was used for the 3.2% missing values for the remaining variables.

A process evaluation included information on routes established and child attendance. Two routes were established at 3 intervention schools and 1 route at the remaining school. The intervention schools each had 7, 10, 18, or 30 children who walked in the program. The mean number of trips the children made to or from school was 20.9 ± 13.4 over the 4- to 5-week period. Each route had a mean of 4.1 ± 3.5 children participating daily. No adverse events (eg, pedestrian injuries) were reported or identified by parents, school staff, or study personnel during the study.

In bivariate analyses of the potential mediating variables and percent active commuting, only parent self-efficacy was significantly related to percent active commuting ( $r = 0.182$ ;  $P = .032$ ), although parent outcome expectations had borderline significance ( $r = 0.165$ ;  $P = .052$ ).

The intraclass correlation coefficient due to clustering within schools for percent active commuting was 0.04. In the intention-to-treat analyses, intervention children increased their weekly percent active commuting from 23.8% ± 9.2% at time 1 to 54.0% ± 9.2% at time 2, whereas control children decreased their weekly percent active commuting from 40.2% ± 8.9% at time 1 to 32.6% ± 8.9% at time 2 ( $P < .0001$ ). Acculturation ( $P = .014$ ) and parent outcome expectations ( $P = .025$ ) were both significantly and positively associated with the change in percent active commuting.

The intraclass correlation coefficient due to clustering within schools for MVPA was 0.08. Intervention children increased their daily minutes of MVPA from 46.6 ± 4.5 at time 1 to 48.8 ± 4.5

at time 2, whereas control children decreased their MVPA minutes from  $46.1 \pm 4.3$  at time 1 to  $41.3 \pm 4.3$  at time 2 ( $P = .029$ ). Age was inversely associated ( $P = .0014$ ), and male subjects were more likely to increase their daily minutes of MVPA ( $P < .0001$ ). If the extreme outlier for daily minutes of MVPA was included in the mixed model analysis, the difference between groups was attenuated and of borderline significance ( $P = .07$ ). With the extreme outlier (ie, with an intention-to-treat basis), intervention children increased their daily minutes of MVPA from  $48.7 \pm 5.5$  at time 1 to  $51.4 \pm 5.5$  at time 2, whereas control subjects decreased their MVPA minutes from  $48.8 \pm 5.3$  at time 1 to  $45.3 \pm 5.3$  at time 2 ( $P = .07$ ). In parallel analyses, intervention children decreased their daily minutes of light physical activity from  $320.3 \pm 13.1$  at time 1 to  $311.9 \pm 13.1$  at time 2, whereas control children increased their daily minutes of light physical activity from  $284.4 \pm 12.6$  at time 1 to  $298.0 \pm 12.6$  at time 2 ( $P = .07$ ). These changes to light physical activity were also of borderline significance. No covariates were retained in the model.

## DISCUSSION

We are the first to report a cluster RCT of a walking school bus intervention that resulted in increased rates of children's active commuting to school and daily minutes of MVPA. Intervention children had a relative increase of  $\sim 38\%$  for percent active commuting compared with control subjects. This increase resulted in meeting objective 22-14b of *Healthy People 2010: Understanding and Improving Health*<sup>12</sup> for children and adolescents to attain 50% of trips to school by walking. The main results confirm epidemiologic studies on children's active commuting, which reported positive associations between active commuting and physical activity.<sup>1-3,19</sup> These results also confirm positive associations reported from

previous walking school bus intervention studies that relied on nonexperimental designs or had small sample sizes but have provided important preliminary data.<sup>15-17,19,20</sup> For example, in a quasi-experimental trial, walking school bus children attained  $\sim 11$  more minutes/day of physical activity than control subjects.<sup>17</sup> Our walking school bus program achieved a relative increase of  $\sim 7$  minutes/day more of MVPA using a higher threshold of 4 metabolic equivalents, which represents 11.7% of the recommended 60 minutes/day for MVPA.<sup>5,44</sup> Another benefit of the walking school bus program was the  $\sim 36\%$  decrease in motor vehicle commuting, which has implications for school-related traffic, pedestrian injury risk, and air pollution.<sup>45</sup>

Parents' outcome expectations were a significant influence on their children's active commuting through the walking school bus intervention. This finding contrasts with our study's previous baseline results, in which only parents' self-efficacy was a significant correlate of their children's active commuting.<sup>25</sup> This difference may reflect the greater importance of parents' outcome expectations (costs/benefits of active commuting) in deciding whether their children may walk to school as part of an organized walking school bus group in contrast to self-efficacy (sense of personal control), which may be more important when a walking group is not offered. In contrast to previous observational studies,<sup>25,35</sup> this intervention study revealed a positive association between acculturation and active commuting rather than an inverse one. Although this finding needs confirmation among other walk to school interventions, it suggests that acculturated parents and children may be more willing to participate in the program and the need to increase outreach and cultural

adaptation for less acculturated parents and children.

Limitations of our study include (1) small sample size (8 schools and 149 participants), (2) brief intervention period, (3) limited generalizability, (4) missing accelerometer data, (5) lack of data on the built or social environment (both have been associated with active commuting<sup>46,47</sup>), (6) baseline differences in percent active commuting between intervention and control subjects despite randomization, and (7) intraclass correlations exceeded sample size estimations and reduced the power to detect an effect.

## CONCLUSIONS

The walking school bus program increased children's active commuting and MVPA, providing preliminary proof of concept for this intervention. Parents' outcome expectations and family acculturation influenced the program's effects on children's active commuting, which underscores the importance of parents and the family's sociocultural environment on children's health-related behaviors, even among those that occur outside of the home.

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